Microstructures in the Indian Foreign Exchange Market

by

N R Bhanumurthy*

Abstract

The present study examines the relevance of macroeconomic models vis-à-vis models based on the market microstructure theory in the context of short-run behaviour of the Indian foreign exchange market. In specific, the paper investigates the relative importance of macro (domestic interest rates) and micro (order flows and number of transactions) variables in determining the short-run exchange rate movements. Empirical analysis is based on both secondary data and on a primary survey of the Indian foreign exchange dealers.

Analysis of the secondary data reveals that micro variables (order flow) have a significant impact on the exchange rate movement compared to macro fundamentals. The primary survey corroborates these findings. That is, a majority of the dealers feel that short-term changes in the Indian Rupee/US dollar market are basically influenced by the micro variables such as market movement, speculation, Central Bank intervention, etc. One of the major findings of this study would be that the dealers feel speculation would increase volatility, liquidity and efficiency in the market and on the other hand, Central Bank intervention reduces volatility and market efficiency.

* Development Planning Centre, Institute of Economic Growth, Delhi University Enclave, Delhi-110 007, India. E-mail:bhanu@ieg.ernet.in; nrbmurthy@yahoo.com

This is part of the study sponsored by ICICI Research Centre. An earlier version of this paper was presented in a seminar at the Institute of Economic Growth. The author would like to thank the seminar participants for their comments. However, any errors and omissions in the paper are the author's alone.

Microstructures in the Indian Foreign Exchange Market

Introduction

After the collapse of the Bretton Woods system in 1973 the exchange rates have shown much volatility. Since then a lot of research has been undertaken to understand the behaviour of exchange rate movements. Some of the perennial questions that were raised are for example: what are the determinants of exchange rate? do exchange rates follow a specific pattern?, is there any theory that can help us in predicting the rate movements?. Many approaches developed in the area of open economy macroeconomics have tried to address these questions. However, these approaches have had some success in explaining currency movements only in the medium and the long-term. But these macro fundamental theories however, could offer no explanation for the short run exchange rate movements in the market (Evans & Lyons, 1999). Particularly after the seminal work of Meese & Rogoff (1983) it was found that forecasts based on the monetary approach to exchange rate determination could not out-perform the random walk forecasts; the macro models lost their allure subsequently. In fact even after two decades of this finding, there is no such claim that theories based on fundamentals can provide best forecasts for the exchange rate movement (see Mark, 1995; Mark & Sul, 2001; Cheung, Chinn & Pascual, 2002; and Chinn & Meese, 1995). A recent study by Neely & Sarno (2002) raises an important query: why should fundamentals forecast exchange rate movement? There is a need to address this basic issue so as to strengthen the research in exchange rate economics and also to chart the future direction for this. As exchange rate forecast is a necessary datum for policy makers to determine the output and inflation in the economy as also for fund managers to plan their asset allocation, Neely & Sarno (2002) argue that instead of forecasting exchange rates through fundamentals, the agents can directly predict output, inflation and uncovered interest rate parity (UIP).

The above two views only question the relevance of existing macro approaches in the exchange rates economics. But both the views ignore the role of the time horizon in judging the efficacy of macro theories. As exchange rate is an output derived out of market behaviour, merely concluding that the exchange rate follows a random walk would mean that the market forces behind this rate are erratic irrespective of the time horizon. This is a conclusion to be contested and it needs to deliver answers both at theoretical and the empirical level. On the other hand, an over dependence/belief in macro theories to explain and forecast

exchange rates fairly accurately at all time horizons is also not completely acceptable. From the literature, one may find that there are some mixed results regarding the macro fundamental theories' ability to explain exchange rate behaviour in the long-run. But in the short-run, recent studies, particularly after the introduction of on-line trading systems that make the tick-by-tick (high frequency) data available, have shown that macroeconomic fundamentals are hardly useful in predicting the rate movement (see Sarno & Taylor, 2001, for the survey). Hence, there is a need to search for some factors that can explain the exchange rate movement based on the time horizon. In this study we try to investigate the factors that determine the exchange rate in different time horizons with the help of both secondary data as also primary information collected from the Indian foreign exchange dealers.

This study is organised as follows. In Section II, we discuss briefly one of the alternative theories on asset price determination in the finance literature (namely market microstructure theory). Section III contains a review of the empirical literature. In Section IV are laid down the specific objectives and database used in this study. Sections V and VI discuss the empirical findings based on secondary data and primary data, respectively. Accordingly the conclusions are drawn in the last section. (All the tables and graphs have been provided in the Appendix.)

Section - II

The present study questions the relevance of macro theories in explaining and predicting day-to-day movements in the foreign exchange market. It is implicitly acknowledged that fads and/or speculation are the most important aspects of intra day/day-to-day transactions in the foreign exchange markets rather than fundamentals. This is because the speculative agents' role may be an important factor on influencing the short-term behaviour of the market. Further, it was found that the role of fundamentals is either insignificant or is tending to be so in recent years. The problems of policy inconsistency and the so-called 'good news' and 'bad news' effects seem to be playing a more dynamic role in the exchange market behaviour today. From the current macro approaches it is seen that these consider only fundamentals such as relative income, relative prices, interest rate differentials, relative cumulated current account balances etc. But in practice, do the market participants (dealers) consider only macro economic fundamentals such as these or do any other variables (that are micro in nature) become relevant to these movements? Particularly in the short run, where transactions

tend to occur in a very short time span, it may be easily understandable that practitioners do not consider these macro variables at the moment of forming their expectations; "... market participants do not in fact all use a common agreed-upon model for thinking about the foreign exchange market and do not all share the same expectations at any point of time." (Frankel & Froot, 1996). Also the frequency of changes in macro fundamentals is very low.

Now the question that remains is that, in the short run, what are the factors that affect the dealers' decision-making? In the literature it was found that more than macroeconomic fundamentals, the dealers consider other variables that are micro in nature (Lyons, 1995). The micro variables are bid-ask spreads, trading volume, own volatility, nonsynchronous trading, information (both private and public), inventory cost, etc. In the financial economics literature, to study the behaviour of asset prices and the market participants the researchers mostly use the *market microstructure theory,* which is the only theory that considers all the micro variables. In the next sub-section we discuss this theory and some of the existing empirical studies in brief.

Market Microstructure theory:

Market microstructure theory is defined as the study of the process and outcomes of exchanging assets (i.e., currency, stock, etc.) under explicit trading rules (O'Hara, 1995). While much of economics abstracts from the mechanics of trading, the microstructure theory analyses the way in which specific trading mechanisms affect the price formation process in the financial markets. These trading mechanisms may differ from one market to the other. For example, in the stock market, trading is centralised and synchronous but in the foreign exchange market trading is decentralised and nonsynchronous. However, irrespective of the type of trading mechanism, prices emerge for the assets when buyers and sellers interact. But the question is whether the equilibrium price that emerges is based purely on the interaction of only demand and supply factors that emanate from the desires of the trading agents, as our microeconomic theory explains? This enquiry forms is the beginning of the study of the microstructure theory.

Microstructure theory consists of two models namely the inventory model and the information model. The crux of the inventory model is the problem of optimisation as the dealers' objective is to maximise expected profit per unit of time. The model emphasises control of the inventory fluctuations through price adjustments to avoid bankruptcy and failure at the

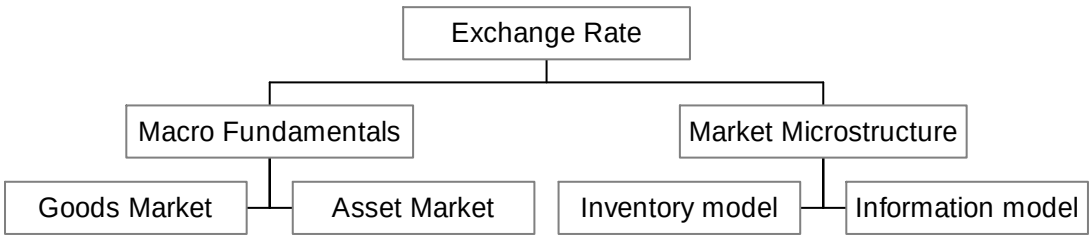
end of dealing. This model also explains the relationship between the transaction cost and the bid-ask spreads. Information models, which are based on the adverse selection problems, explain the behaviour of market prices through the information contents of the traders. Since there exist asymmetries of information between the dealers, their behaviour in making the quote will be different. These information models also explain how the equilibrium market price emerges in the presence of asymmetric information.

In microstructure theory there are two variables that occupy the centre stage, neither of which had any role in the macro approach. These variables are: (a) Order flow, (b) Bid-ask spread. Both these variables are synonymous with the 'quantity' and 'price' in traditional microeconomics. Order flow, as used in microstructure theory, is a variant of a key term in microeconomics, namely, "effective demand". It measures the net buyer-initiated orders and seller-initiated orders. Here the word 'initiated' is very important in differentiating between order flow and the effective demand. In microstructure theory, orders are initiated against a dealer. The dealer stands ready to absorb imbalances between buyers and sellers. These 'uninitiated' trades of the dealer account for the wedge between these two concepts.

Micro-Macro divide:

The core distinction between the microstructure approach and the asset approach is the role of trades. Under the asset approach, trades play no role, whereas in microstructure models they are the driving force. We frame this distinction by considering structural models within these two approaches with the help the flowchart that is presented below.

Exchange Rate Determination



The equations of exchange rate determination within the asset approach are typically estimated at the monthly frequency, or lower, as the adjustment between the variables would take a time lag of one month or more and also due to the availability of some of the exogenous variables in this approach. The estimable equation would of the form:

$$E_t = f(i, m, \ldots) + \varepsilon_t \quad (1)$$

Where E_t is the nominal exchange rate over the period. The driving variables in the function include current and past values of home and foreign interest rates 'i', money supply 'm', and other macro determinants like trade balance, fiscal deficits, etc. Here, changes in public information variables drive price without any role for order flow or spreads. If any price effect from order flow should arise they would be subsumed in the residual ε_t. Though logically coherent and intuitively appealing, a long literature documents that these macro determinants account for only a small portion of the variation in the floating exchange rates.

Equations of exchange rate determination within the microstructure approach are derived from the optimisation problem faced by the actual price setters in the market, namely the dealers. This takes the form of variations on the following specification:

$$E_t = g(Q, I, \ldots) + e_t \quad (2)$$

Where now E_t is the change in the nominal exchange rate between the two transactions. The driving variables in the function include order flow (Q) signed so as to indicate direction, a measure of dealer net positions, or inventory (I), and other micro determinants. Here, e_t would capture the effects of macro variables like output, interest rates etc. It may be interesting to note that the residual in this case is just a mirror image of the residual in equation 1, in that it subsumes any price changes due to the public information of the asset approach.

To establish the relative importance of the micro and macro approaches, the study estimates the following equation with components from both approaches, which is based on the methodology developed by Evans & Lyons (1999).

$$E_t = f(i, m, \ldots) + g(Q, I, \ldots) + v_t \quad (3)$$

Given this theoretical background, the present study tries to examine the effect of micro (order flow and number of transactions) and macro (daily domestic interest rates) variables on the Indian rupee/US dollar (henceforth INR/USD) exchange rate behaviour with the help of high frequency data (Reuters screen) for the whole month of August 1999, which consists of 22 working days. This data has been made available by Olsen & Associates, Switzerland. A study of this kind has assumed importance in the Indian context particularly after 1991. With the introduction of economic reforms, particularly in the financial sector and foreign investment, volatility in exchange rates may be more intense especially due to the opening up of markets, increasing business of multinational enterprises, increasing foreign institutional

investments, and full convertibility on the current account. Now that there is talk of full convertibility on capital account also, it is very important to understand the exchange rate dynamics. (In the Indian foreign exchange market, the daily transactions amount to more than one billion US dollars.)

Section III

Review of literature

Until recently the application of market microstructure theory was limited to the security markets. Its application to the foreign exchange market has begun only in the early 90s, particularly after the introduction of trading systems like the Reuters and Telerates through which the market participants, mostly banks, can complete their transactions electronically in a short time span. These systems made the transactions very easy and reduced the time and transaction costs in the market. This also made available the high frequency data on exchange rates, which helped the researchers in this area to study the market behaviour in the short run and also in its forecasting in the short-run.

One of the basic studies in this area is that of Goodhart & Figliuoli (1991). In this study, for the first time, high frequency data on exchange rates has been analysed and many issues have been raised for further research. However, the application of microstructure theory to exchange rates was initiated by a pioneering study by Lyons (1995). While there are few studies that applied microstructure theory these are however, restricted to the leading currencies like the US dollar, Deutsche mark and Japanese yen. These studies are briefly discussed in this section.

As mentioned in the preceding section, the models based on microstructure theory (particularly the information models) are very useful in explaining changes in the exchange rate movements. Under information models there are two types of studies that exist in the literature: one that concentrates on the public information, which is uniformly available to all participants in the market and its impact on the exchange rates in the short-run; second, the presence of private (and/or asymmetric) information, which is available to individual participants, and its impact on the volume and the rate changes. Researchers explored both the cases with the help of high frequency data and with advanced econometric tools. But there are not many studies that applied the inventory models and this is due to an unavailability of information relating to the order book of the dealers in the foreign exchange market. Here we briefly review some of the existing empirical studies.

Among the variables specified, information is considered as the most important variable in the literature and the effect of this variable has been tested extensively. Bollerslev & Domowitz (1993) studied the intraday-trading activity in a foreign exchange market by considering the 'quote arrivals' and 'bid-ask spreads' recorded for deutsche mark-dollar exchange rate data. The study examines the volatility, news effects and the impact of market activity on the returns. It is found that the intensity of quote arrival, which is taken as a proxy for the volume of transactions, has a negative but economically and statistically negligible effect on conditional volatility. News arrivals in the form of number of transactions have no effect on the conditional variance. Information in the form of lagged spread provides a powerful positive and strongly statistically significant effect on the conditional variance. It was found that the bid-ask spreads exhibit a non-stationary process. Changes in the spread are highly negatively serially correlated, with an unconditional mean of zero. The study strongly rejects the restriction that trading activity does not affect the conditional mean and variance of the spread. But it is found that variances in trading activity have a highly statistically negligible effect on the conditional mean.

Lyons (1995) tried to examine the microstructural hypotheses in the case of the deutsche mark/dollar exchange market by using the data of indicative quotes that are the input in Reuters by a trading bank, for a period of five trading days. The data consists of three components. These are:(1) time-stamped quotes, prices, and quantities for all the direct inter-dealer transactions of a single deutsche mark/dollar dealer at a major New York bank; (2) the same dealer's position cards, which includes all indirect (brokered) trades; and (3) time-stamped prices and quantities for transactions mediated by one of the major New York brokers in the same market. By using the multiple regression model, the study estimates both the models in the microstructure literature, i.e., inventory model and information model. The study finds that order flow affects prices through both the information and inventory channel. Between both the results, the study found that the result for the inventory channel is more novel, i.e., it induces more than 75% for every $10 million of net positions.

Ito, Lyons & Melvin (1998) probe the presence of private information among the participants in the Tokyo foreign exchange market, which was closed for trading over the lunch break. On December 22, 1994, this restriction was removed. And this deregulation provides new insights into why return volatility is so much higher during trading hours. The paper examines a wide range of microstructural hypothesis. By using the spot rates of yen/dollar

and mark/dollar, the study concludes that there is strong evidence that lunch volatility increases with the opening of the trade. The lunch period trade demonstrated flattening the volatility U-shape as the result shows that lunch variance is substantially lesser than both morning and afternoon variance in the closed sample. But lunch variance rises relative to both morning and afternoon variance after the trade opens in the lunchtime. About the results for the third hypothesis, it is supported by the data. It was found that the pronounced variance increases in the hour preceding the lunch break. Once the lunch hour trade opens, this peak variance vanishes and the familiar full day U-shape appears. In the case of fourth hypothesis, it is found that the morning variance actually falls slightly after the opening lunch-hour trade. The afternoon variance clearly rises after opening lunch-hour trade. This change is consistent with information whose private value is short-lived. For the last hypothesis, it is found that dollar/mark volatility over lunch also rises significantly, but by less than the yen/dollar. Thus, the study concludes that there exists private information in the foreign exchange market, which is against the common view on the subject.

In the spirit of the Ito, Lyons and Melvin (1998) study, Andersen, et al. (1998) also tried to re-examine the presence of private information in the Japan foreign exchange market with the help of new procedures and found that the volatility increases during the Tokyo lunch period dealing following the lifting of the trading restrictions. But it rejects all other conclusions that are derived by Ito, et al. (1998) when longer pre-and post-December 22, 1994 data are used.

Andersen & Bollerslev (1998) try to examine the deutsche mark/dollar volatility in the intraday trading activity. With the help of data with five minutes frequency, the study finds that largest returns appear to be strongly linked with the release of public information and, in particular, certain macro economic announcements. But when explaining the volatility of the returns, the study concludes that public information is secondary. The major announcements dominate immediately following the release, but their explanatory power is lesser than that of the intraday pattern at the high frequencies, and much less than that of standard volatility forecasts at the daily level. It was also found that the clustering of public information releases on certain weekdays explains the day-of-week effect.

Evans & Lyons (1999) try to develop a model by including both micro and macro variables to test their comparative efficiency in tracking the changes in exchange rate. For this purpose, the study considered the daily data of deutsche mark/dollar and yen/dollar exchange rates.

Order flow, which is defined as net of buyer initiated trades to seller initiated trades, is taken to represent as micro variable and interest rate is taken as macro variable. It is found that order flow and nominal exchange rates are strongly positively correlated. The study tests a portfolio shift model, where order flow was considered as the main microstructure variable and interest rate differentials were considered as macro variable, and concludes that order flows are better predicators of the exchange rate changes. The model produced R^2 statistics above 50 percent. It also produces better out-of-sample forecasts than a random walk model.

In the INR/USD market, Bhanumurthy (2000) has examined the impact of public information on the rate changes with the help of high frequency data for one month. When the news variable was not considered in the estimates, the study found that the exchange rate is stationary. Also the coefficients of lagged difference terms are highly significant. The study shows that there exists a very well defined autoregressive effect in the conditional variance term. When the news variable is included, the results show that the news variable is highly insignificant and, hence, the efficient market hypothesis is rejected in the Indian foreign exchange market. But it was found that the autoregressive effect is present in the series. The estimated model shows that the conditional variance has an impact on the exchange rate. Since, the market knows the date of the announcement of the news, there is a possibility that an anticipated increase in uncertainty could occur in advance of the news announcement itself. Even after conditioning for anticipation, the results show that INR/USD is found to be insensitive to any type of news and hence the study infers that the Indian foreign exchange market is 'inefficient'. The study concludes that irrespective of the nature of the news, the outcomes in the market will not include the impact of these reports and will continue to be independent.

From a review of the studies on microstructures in the foreign exchange market, it was found that most of them are fairly recent. This indicates that the study of micro issues in exchange rate behaviour is a recent phenomenon. We also find that most of the studies have concentrated on the leading currencies like deutsche mark/US dollar, Yen/Dollar and Pound/Dollar[1]. This may be because of high market activism in these currencies.

[1] It may be noted that these studies have concentrated on the three major currencies, as their turnover is very high compared to other exchange rates. The annual turnover of these currencies in 1989 in New York foreign exchange market are 33%, 25%, and 15% for deutsche mark/US dollar, Yen/US dollar and Pound/US dollar, respectively.

It is observed from the above literature survey that the study on micro issues in the foreign exchange market is limited to the three major currencies (mentioned above) and to the information models. Only one study (Evans & Lyons (1999)) has tried to establish the relative importance of theories based on macro fundamentals and microstructures. In the present study we attempt to examine this issue of the micro-macro divide in the INR/USD market. In the Indian foreign exchange market, until recently the transactions were completed only with telephone contacts while the Reuters screen helped to identify the dealing party. But the Reserve Bank of India has recently allowed the transactions to be undertaken directly through the Reuters' system. This may lead to more activism in the market and would lead to an increase in the number of transactions. This situation would force the market players to understand the trends in the market properly. For this purpose, it is necessary to study the behaviour of high frequency data in the Indian foreign exchange market. In the present study, we examine the impact of macro and micro variables on INR/USD for the month of August 1999. But this kind of analysis would be incomplete if the perceptions of traders, who are the real decision makers in the market, about the importance of macro fundamentals in determining the exchange rates in the short-run are not taken into account. Cheung & Chinn (1999) recognised this issue and undertook a survey on foreign exchange dealers in the United States. This study probes the causes and determinants of bid-ask spreads and the predictability of exchange rates in the short-run. It was found that majority of the traders responded that the predictability of exchange rate changes is very low in the intra-day. And in the medium and long run more than two-thirds of the traders view that exchange rates cannot be predicted. Though this study did not focus on the factors that determine exchange rates over the time horizon, it has marked a beginning in the survey-based studies on the foreign exchange market.

In continuation with the above study, Cheung, Chinn & Marsh (2000) have done a survey on the UK-based foreign exchange dealers in 1998. This study focuses on three aspects: (1) the microeconomic operation of the foreign exchange market; (2) the beliefs of dealers regarding the importance of macroeconomic fundamentals in understanding exchange rate movements; and (3) microstructure variables in the foreign exchange market. The study found that a majority of the dealers held the view that non-fundamental factors dominate the short-term exchange rate movements. Alternatively, it was found that speculation is an important factor in the short-term market. Further, the dealers believe that fundamentals have significant effects on exchange rates in a much shorter time frame than is expected by the macro

theorists. Regarding the concept of purchasing power parity, the study concludes that though the dealers accept it as representative of the exchange rate's fundamental value, however the trading would not be based on this. Lastly, market convention has been found as an important determinant of bid-ask spread. (Cheung & Wong (2000) has further extended this survey to Hong Kong, Tokyo and the Singapore foreign exchange markets.)

Taking the cue from the above empirical and survey-based studies, the present study, which is the first of its kind on the developing country's foreign exchange market, attempts a similar exercise in the Indian context. One important difference, rather uniqueness, of this study as compared to the other studies is that it analyses the behaviour of INR/USD market based both on secondary data and also on the information collected from traders. In the next section, we specify the objectives and also the database used in the present study.

Section IV

Objectives of the study

It is significant that in the RBI's *Report on Currency & Finance, 1999-2000* (page IV-18-19), the Central Bank has raised the issue of studying the foreign exchange behaviour in a market microstructure framework. The apex bank has indicated that the movements in the macro fundamentals may not back exchange rate movement in India in all time horizons. In this context, the present study would try to analyse the factors behind changes in the exchange rate in the short run. Also, an attempt will be made to discern dealers' perception regarding the market movement and the forces behind it in the case of Indian foreign exchange market.

The specific objectives of the present study would be as follows:

1. To test the importance of macro economic fundamentals in different time horizons by using both secondary and primary information.
2. To examine the importance of microstructural factors in the short-term rate movement.
3. To find out the predictability of exchange rates in different time horizons.
4. To analyse the effects of speculation and Central Bank intervention on the rate movement.

Data base

For this study, we have collected primary information from the market practitioners (dealers) with the help of a structured questionnaire. (The specimen copy of the questionnaire has been

provided in the Appendix.) For secondary analysis, the study uses the high frequency data on Indian rupee/US dollar exchange rate that appeared on the Reuters' screen and provided by Olsen & Associates (Switzerland). The high frequency data covers 22 working days in August 1999 with the number of observations being 4981. For daily interest rates, we have taken daily call money rates that are provided by the RBI *Monthly Bulletins*. For the order flow, since the volume of transactions is not available we have taken daily foreign currency turnover in the inter-bank spot market, which is also available from the *Monthly Bulletin*. Further, we have also taken number of quotes in a day as one of the microstructure variables and this has been calculated from the high frequency data (Stoll, 1999).

Section V

Empirical Results based on secondary data

Before analysing the regression results, we discuss the descriptive statistics of the high frequency data that is used in the study. Both the bid and ask prices are plotted in Chart19 and the bid-ask spreads are plotted in Chart 20. The summary statistics are presented in Table 2. It may be found from the summary statistics that the average bid-ask spread, which is widely accepted as a proxy for the transaction cost, in INR/USD is very high compared to other markets[2]. This indicates that the INR/USD market is not very 'thin' and that the volumes are low in this market. (It is established in the finance literature that the spreads and volumes are strongly negatively correlated.) The coefficient of kurtosis is very high in INR/USD market, indicating that INR/USD market's spreads are not in tune with the 'true' or 'fundamental' market values. The participants in this market may be termed as 'defensive players' given the high spreads. From the graph on bid-ask spreads of INR/USD, we can see the high variation in the spreads as the graph shows many 'pillars' indicating defensiveness and low volumes of the INR/USD dealings. To establish the importance of macroeconomic fundamentals and the microstructural variables on the exchange rate movement, we estimated regressions with different specifications. The results are presented in Table 3 and would be analysed in the following sub-section.

Micro-Macro divide

The study tries to examine the relative importance of micro variables over macro variables with the help of daily order flows in the market. Since the information on buyer-initiated trades and

[2] In the case of Japanese and the Euro foreign exchange markets the average spreads are 0.0001.

seller-initiated trades are not published, the present study considers the daily turnover of foreign currency (in million US dollars) in the Indian foreign exchange market. The study also considers the number of transactions in the market taking the view of Hans Stoll that the number of transactions will be the most important variable in predicting the short-term changes in the asset market prices. For macro variables, the study considers the Indian daily call money rates. In Table 3 we have presented only the specifications that have high explanatory power (in terms of adjusted-R^2). We have also used a time lag to capture the 'left out effect', which is usual in the financial markets.

From the table it may be noted that in the first model, where only domestic interest rate is included in the equation, interest rate found to be positive and highly significant. In the second model, we estimated exchange rate only on microstructural variables (namely turnover and number of transactions) and found that both the variables turned out to be positive and highly significant. These results show that independently both fundamentals and micro variables seem to have a significant impact on the daily rates. To establish the relative importance of macro and micro variables, we have included both in the estimation and estimated this with different combinations. Hence, when we regressed the exchange rate on interest rates, turnover and the number of transactions, both the micro variables turned out to be highly significant. But interest rate turned out to be insignificant. In all the other combinations also, the interest rate turned out to be insignificant, whereas the micro variables have a significant impact on the exchange rate. The study corroborates the findings of Evans & Lyons (1999). This result supports the disclaimers of macro theories on exchange rate determination models. But it also does not support the findings of Meese & Rogoff (1983) that exchange rates follow a random walk process. There are some factors that explain the exchange rate movement that are micro in nature. To substantiate these results, we have undertaken a primary survey of the Indian foreign exchange dealers. This will be discussed in detail in the next section.

Section VI

Empirical results based on primary survey

A structured questionnaire has been prepared and mailed to the foreign exchange dealers, who are registered with the Foreign Exchange Dealers' Association of India (FEDAI)[3]. In India, foreign exchange dealing rooms are located in seven cities (Ahmedabad, Bangalore, Chennai,

[3] Though there are some private primary dealers in the market, in this study we have covered dealers from the banks only.

Delhi, Kolkatta, Kochi, and Mumbai). (The information on number of banks in each city can be found in Table 1). But it has been observed that most of the operations have been undertaken by the banks in Mumbai, Chennai, and Bangalore. Some of the dealing rooms in Mumbai, Chennai, Bangalore and Delhi were visited and discussions were held with dealers and the questionnaires were filled. For the remaining dealers, questionnaires have been mailed. A total 91 dealers (around 23.3% of registered dealers) have responded to our questionnaire. For a study of this kind, 23% would be a very good response. One of the problems that the researcher faced was that from most of the dealing rooms, where there are many dealers, the response was one or limited to a maximum of two. The reason for this poor response is due to the dealer's assumption that all the dealers in a dealing room would have the same perception and make the same decisions. But to the surprise of the researcher, it has been found that, wherever the responses are more than one from a single dealing room, no two dealers from same bank have same perception and possess same decision-making principle.

Field Impressions

The researcher has faced many interesting issues that have arisen in the process of collecting the information and discussions with the experts. One of the major issues that need to be highlighted is that of conventional spread in the Indian rupee/ US dollar market. Unlike in other major foreign exchange markets like the Yen/USD, Euro/USD, and USD/Pound, there seems to be disagreement among the dealers regarding the conventional spread in the rupee/USD market. It was found that out of 91 responses, around 40 dealers specify that there is conventional spread and it is half a paise. The remaining dealers disagree with this and some have specified a quarter paise and some have specified one paise.

Another interesting issue that was brought out in the discussions is that the role of Central Bank in the foreign exchange market behaviour. Most of the dealers are highly critical about the RBI's intervention in the market. Some have even felt that there is no market for foreign exchange in India as the movement of asset prices depend more on the RBI's behaviour than on the demand and supply factors. It was reported that some of the big players have shifted from the foreign exchange market itself.

Distribution of the sample (spatial and dealers' profile)

It may be noted from Table 1 that in India, in 2001, there were 144 dealing rooms and 391 dealers. These dealing rooms are spread over seven cities specified earlier. For this study, we could collect information from 91 dealers. The spread of the sample can be seen in Chart 1. About two-thirds (61.5%) of the sample is from Mumbai. Chennai and Delhi consists of 17.6% and 9.9%, respectively. From other cities like Bangalore and Kochi, we could get only 9 samples. The unspecified slice of the chart is one sample from Kolkatta. We could not get any response from Ahmedabad.

The profile of the sample includes Managers, Treasurers, Chief/Senior dealers, and dealers/junior dealers. It may be noted from Chart 2 that a large portion of the sample (about 49.5%) are dealers/junior dealers. Chief/Senior dealers are about 40.7%. We got only 9 responses from the Managers/Treasurers. In terms of experience, around 57% of people are having less than five years of experience and around 37% people have between 6 to 10 years and the remaining 6% (exploded slice in Chart 3) have more than 10 years of experience. We have adopted this distribution basically to capture the changes in the trading systems and strategies over a five-year period.

Daily dealing and bid-ask spread

We have also collected the information regarding volume of transaction of the bank so as to determine the size of the bank. Given the sensitivity of this information we could get responses only from 69 dealers (about 75%). It is also observed that most of the deals are in Indian rupee/US dollar market and other foreign currencies like Euro are traded in crosses with US dollar. The range of dealing is found to be very large (minimum is US$ 0.5 million and maximum US$500 million). From Chart 4 it may be noted that around 45% of the responded banks have a daily dealing between 10 to 50 million US dollars. An interesting aspect is that about 19% banks have a daily dealing of more than 50 millions. This shows how important it is to study the India foreign exchange market behaviour.

The study tries to examine the basis of foreign exchange trading in India. In doing so the data on current trading and the trading five years ago has been collected from the banks. It has been found that five years ago, foreign exchange was traded mostly to adjust the changes in fundamentals and complete the customer orders. But presently there seems to be a significant shift from these trades to the trading based on technical factors. (Over the last five years

technical trading has increased substantially from 33% to 62%, whereas trading based on customer orders have declined significantly from 42% to 25%.)

Another important objective of this study is to know what are the determinants of the bid-ask spread of the quotations. It has been found that a majority of the respondents (around 70%, see Chart 5) determine their spreads based on the market convention and around 21% determine this based on their potential costs of making the quote. But the information on spreads in INR/USD market shows a different picture. About 60% dealers quote the spread of half a paise and about 23% of dealers quote a one paise spread. Also the discussions with the dealers found that though the spreads are quoted on the basis of market convention, the conventional spread is not the same across the banks.

Market convention and spreads

For a smooth functioning of the market, it is necessary that the bid-ask spreads quoted should follow the market convention. If both differ, then it may lead to or be led by some factors that are exogenous to the market, like unexpected changes in the fundamentals, political news, etc. In this study we find mixed results (see Chart 7). There are 30% of dealers who have less than 5% of their quotes as larger than conventional spread. In the same way there are 22% dealers who have less than 30% of their quotes smaller than conventional spread.

But why should the dealers quote their spreads differently from the conventional one? Or, why should the dealers quote the conventional spread? For the first question, more than 30% of the dealers answered that the presence of increased market volatility, holding position against the market trend, and unexpected change in the market activity due to various reasons are the prime factors (see Chart 8). For the second question, more than 45% of the dealers felt that securing a good market image of the bank and maintaining reciprocal relationship with other banks are the main reasons (see Chart 9).

Determination of exchange rates

One of the important questions this study address is what are the factors that determine the exchange rates in any economy? In the area of international money and finance, there are many theories that explain the exchange rates. But are these theories helpful in practical trading? To answer this, we have asked the dealers what are the important factors that determine exchange rates over time horizon (like intra day, medium run, and the long run). It

is interesting to note that in the intra day trade factors like news[4] (68.1%), bandwagon effect (50.5%), speculation (50.5%), and order flow (55.5%) are important (see Chart 10). One striking thing is that no body expressed that economic fundamentals are important in the intra day trades. But in the medium run and long run economic fundamentals seems to be a major factor in determining the rate movement. In other words, over the time horizon the importance of economic fundamentals is increasing. From this it can be concluded that macroeconomic theory may be useful only in the medium and long run. But to study the market behaviour in the short run one would need to consider non-macro fundamentals like news, order flow, etc. These are the major elements of market microstructure theory.

Macroeconomic fundamentals indeed have a role in the exchange rate determination. But it is not in the intra day. It may be noted from the Chart 12 more than 80% of dealers feel that in intra day trading fundamentals play an insignificant role. Over the time horizon the importance of fundamentals is increasing. If the intra day changes in exchange rate does not reflect changes in economic fundamentals, what are the other variables responsible? The response was loud and clear that both speculation and the central bank intervention are the major determinants (see Chart 11). This vindicates the impression that in India the central bank plays a 'spoil sport'[5] in the foreign exchange market activity and the rates move accordingly. But one may be interested to know what would be the exact impact of speculation and central bank intervention on the market.

Speculation, Central Bank Intervention, and the foreign exchange market

In the intra day trading, we found that there are two factors that affect the exchange rate movement, i.e., speculation and central bank intervention. But what is the exact effect of these factors on the market behaviour (like on market volatility, liquidity and market efficiency)? Though it is known that both speculation and central bank intervention could either increase or decrease volatility, liquidity and efficiency, this question was asked basically to bring out the dealers' general perception about the effect of these two factors on the market movement. The dealers were asked the same question separately and these are presented in Charts 13 and 14.

[4] Here the news could be any thing. It can be either political, economical, or some thing else which distorts the dealers expectations.

[5] Some of the dealers have used this word at the time of discussions.

It was found that a majority of the dealers (more than 50%) feel speculation leads to an increase in market volatility, liquidity and efficiency. Contrary to this, more than half of the dealers feel that central bank intervention would reduce both volatility and efficiency in the market. One of the arguments given for the central bank intervention is that to "bring orderly movement" by removing speculation in the market. But the dealers perceive this in the other way. They feel that without speculation there is no 'charm' in the market and the central bank's intervention is very 'depressing'[6].

Macroeconomic announcements and exchange rate

In the intra day, it may be concluded from our survey results that exchange rates do not follow macroeconomic fundamentals. This is true only when the new economic data coincides with the expectations already formed and which are already discounted in the market. But if the new macroeconomic data deviates from the market expectations, the market tries to adjust this new information. Now the question is how fast does the market assimilate the news. This depends on the kind of macroeconomic news. To analyse this, we have taken interest rate, trade deficit, money supply, GDP, and inflation. It was found that among all these variables, interest rate announcements assimilate within ten seconds (see Chart 15). The remaining variables take more than a minute. Further, for the question of which economic announcement has a bigger impact on the market movement now and five years ago, it was found that the importance of interest rate changes has increased substantially over the period (response was 50% five years back and now it is 73%) (see Chart 16). This may be due to a substantial increase in the capital mobility and also the gradual integration of financial markets (both domestic and foreign), which has an immediate impact on the market. But the importance of money supply, GDP and inflation has declined over the period. One reason for this could be that these variables are behavioural and is predictable (unlike interest rate, which is still a policy variable).

Purchasing power parity and the exchange rate

The macroeconomic researchers believe that market practitioners strongly believe in purchasing power parity theory (PPP). It is assumed that the dealers hold their position based on this theory. The dealers' views are in contradiction to the macroeconomic researchers'

[6] From the discussions with the dealers it was found that most of the big players in the foreign exchange market have shifted to other markets. Also it was viewed by these big players that there is no foreign exchange market in India.

belief that PPP condition would be helpful in tracking the exchange rate movement (see Charts 17 and 18). Almost 45% of the dealers were of the view that this is basically an academic jargon. Further, more than 60% of dealers felt that the PPP condition couldn't help in predicting the rate change in the short run. But it can help predict only in the long run.

Conclusion

In the present study we tried to discern the factors that affect the exchange rate movements in different time horizons by using both secondary and primary data. From the secondary data analysis, the study finds that in the short run, more than macro fundamentals, microstructure variables exercise a greater effect on the exchange rates. This finding is also corroborated by the dealers' perception that compared to fundamentals, order flow has a more significant impact on the exchange rates in the intra-day. But it was found that fundamentals are more useful in predicting the rates in the long run. This is a new finding for any developing countries' foreign exchange market. These results might differ between the countries as it depends on the specific country's market regulations, 'maturity' and the economy itself.

Given these conclusions, it can be inferred that the studies on exchange rate determination models should concentrate on the short-term forecasting with the help of micro variables like bid-ask spreads, volume of transaction, order flows, and public & private information. A study of this kind may be of greatly useful not only in predicting the exchange rates near-accurately but also in maintaining orderly movement that helps the risk managers in the market. One of the objections to this conclusion could be that a greater emphasis has been given to the views of the dealers whose objective may be fairly different from that of the Central Bank. Though this may be true to some extent, however one cannot completely ignore the dealers' perception about the established theories in the area of international macroeconomics, as they are the biggest stakeholders in the market. The Reserve Bank of India has been intervening directly into the market to achieve its goal of orderly movement in the market. But that would lead to market inefficiency. It may be suggested that the RBI to follow some indirect measures to achieve its objective, which in turn would also allow the market to function independently.

References

Andersen, G.Torben & Tim Bollerslev (1998), "Deutsche Mark-Dollar volatility: Intraday activity patterns, macroeconomic announcements, and longer run dependencies", *Journal of Finance*, LIII(1):219-265.

Bhanumurthy, N.R (2000), "Information effects in Indian foreign exchange market", conference volume, *Fourth Capital Markets Conference*, UTI Institute of Capital Markets, Mumbai.

Cheung, Yin-Wong; & Chinn, M.D (1999), "Traders, Market Microstructure and exchange rate dynamics", *NBER Working Paper No.7416.*

Cheung, Yin-Wong; Chinn, M.D. & Marsh, W.Ian (2000), "How do UK-based foreign exchange dealers think their market operates?", *NBER Working Paper No.7524.*

Cheung, Yin-Wong. Chinn, M.D. & Pascual, A.G (2002), "Empirical exchange rate models of the nineties: Are any fit to survive?" University of California, Working paper, May.

Cheung, Yin-Wong & Clement Yuk-Pang Wong; (2000), "A survey of market practitioners' views on exchange rate dynamics", *Journal of International Economics*, 51.410-19.

Chinn, Menzie D. & Meese, Richard A (1995), "Banking on currency forecasts: How predictable is change in money?" *Journal of International Economics*, February, 38(1&2):161-178.

Evans, Martin & Richard Lyons (1999), "Order flow and exchange rate dynamics", *NBER Working Paper No.7317*.

Frankel, Jeffrey, Giampaolo Galli, & Alberto Giovannini (1996), *The Microstructure of foreign exchange markets*, (eds), NBER conference report.

Goodhart, A.E, Charles & L.Figliuoli (1991), " Every Minute Counts in Financial Markets", *Journal of International Money and Finance*, 10:23-52.

Goodhart, C.A.E, S.G.Hall, S.G.B.Henry, & B.Pesaran (1993), "News Effects in a High-Frequency Model of the Sterling-Dollar Exchange Rate", *Journal of Applied Econometrics*, 8:1-13.

Ito. Takatoshi, Richard K.Lyons, and Michael T.Melvin, (1998), "Is There Private Information in the FX Market? The Tokyo Experiment", *Journal of Finance*, Vol.LIII, No.3, Pp.1111-1130.

Lyons, R, (1995), "Tests of microstructural hypotheses in the foreign exchange market", *Journal of Financial Economics*, 39:321-51.

Mark, Nelson C (1995), "Exchange rates and fundamentals: Evidence of long horizon predictability", *American Economic Review,*.85(1):201-18.

Mark, Nelson C. & Donggyu Sul (2001), "Nominal exchange rates and monetary fundamentals: Evidence from a small Post-Bretton Woods panel", *Journal of International Economics*, 53(1):29-52.

Meese, R, & Rogoff.K (1983), "Empirical exchange rate models of the seventies. Do they fit out of sample?" *Journal of International Economics*, 14:3-24.

Menkhoff, Lukas (2001), "Short-term horizons in foreign exchange? Survey evidence from dealers and fund managers", *KYKLOS*, 54(1):27-48.

Neely, J. Christopher & Lucio Sarno (2002), "How well do monetary fundamentals forecast exchange rates?" *Federal Reserve Bank of St. Louis Review*, September/October, 84(5):51-74

O'Hara, Maureen (1995), *Market Microstructure Theory*, Blackwell Publishers Inc.

Sarno, Lucio & Mark P. Taylor (2001), "The microstructure of the foreign exchange market: A selective survey of the literature*", Princeton Studies in International Economics-89.*

Stoll, R. Hans (1999), *Microstructure: The organization of trading and short-term price behavior,* (eds) Vol.I, Edward Elgar.

Appendix

Table 1 Total number of dealing rooms and dealers in India (Location wise and only banks)

Location	Number of dealing rooms	Number of dealers
Ahmedabad	2	4
Bangalore	4	11
Chennai	17	37
Delhi	25	57
Kolkatta	12	16
Kochi	5	14
Mumbai	79	252
Total	144	391

Source : ***The Indian Dealing Rooms Directory, 2001****, Forex Association of India*.

Table 2: Summary Statistics for high frequency data
INR/US dollar exchange rate (for the whole month of August, 1999, N=4981)

Statistics	Bid	Ask	Spread
Mean	43.4367	43.4474	0.0107
Variance	0.0043	0.0043	0.00028
Skewness	-0.50008	-0.4483	7.9896
Kurtosis	-0.7355	-0.6866	70.9075

Table 3-Regression results:
Dependent variable= Exchange rate (Rupee/US dollar)

Independent Variable → / Model	INDI	OF	OF(-1)	INRN	INRN(-1)	$\overline{R}^2$
1.	**-3.12*** **(-8.53)**					**0.78**
2.		**0.023*** **(10.62)**		**0.032*** **(3.19)**		**0.96**
3.	**0.208** **(0.603)**	**0.022*** **(7.93)**		**0.029**** **(2.616)**		**0.89**
4.	**0.231** **(0.761)**	**0.014*** **(3.665)**	**0.013*** **(3.562)**			**0.64**
5.	**-0.062** **(-0.216)**	**0.013*** **(3.967)**	**0.012*** **(3.69)**	**0.024**** **(2.66)**		**0.87**
6.	**-0.007** **(-0.029)**	**0.013*** **(4.628)**	**0.01*** **(3.58)**	**0.01** **(1.04)**	**0.023**** **(2.727)**	**0.91**
7.	**0.102** **(0.452)**	**0.013*** **(4.705)**	**0.011*** **(3.55)**		**0.028*** **(4.01)**	**0.98**
8.	**0.578** **(1.616)**	**0.025*** **(8.198)**				**0.87**

'*' Significant at 1% level
'**' Significant at 5% level
Figures in the brackets are t-statistics

Description of the Variables

OF = Order flow

INDI = Indian interest rate (daily call money rates)

INRN = Number of quotes of INR/USD taken place in a day through inter bank dealings (particularly through Reuters D 2000-2 system).

OF(-1) and INRN(-1) are the first lag of OF and INRN.

Chart1-Distribution of sample (area, total 91)

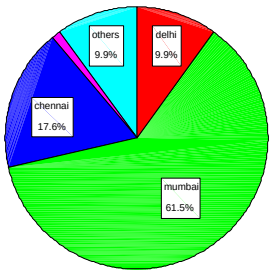


Chart3-Distribution of sample (work experience)

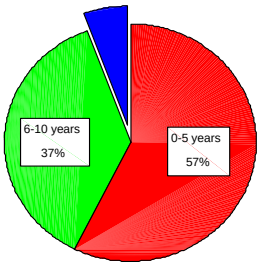


Chart2- Distribution of sample (position)

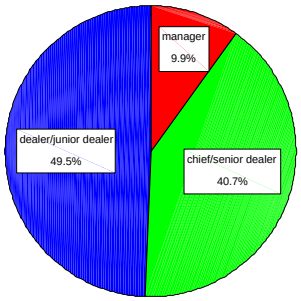


Chart5- Determinants of bid-ask spread

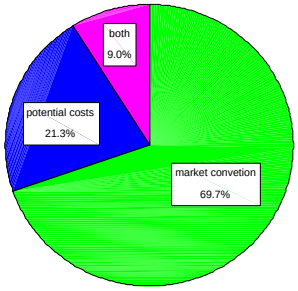
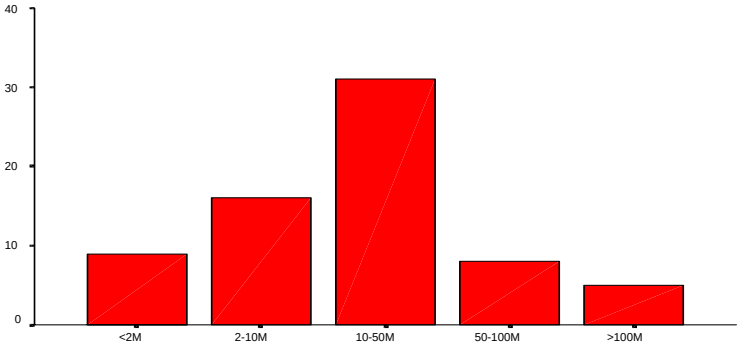


Chart4- Average daily dealing (in $ millions)



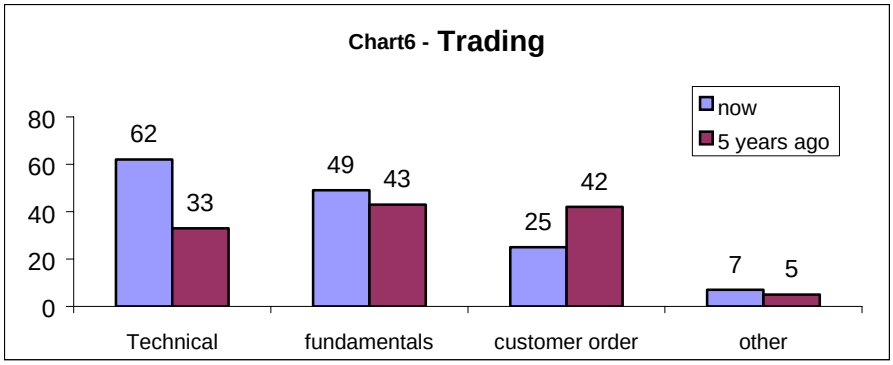


Chart6 - Trading
80
60
40
20
0
62
33
49
43
25
42
7
5
now
5 years ago
Technical
fundamentals
customer order
other

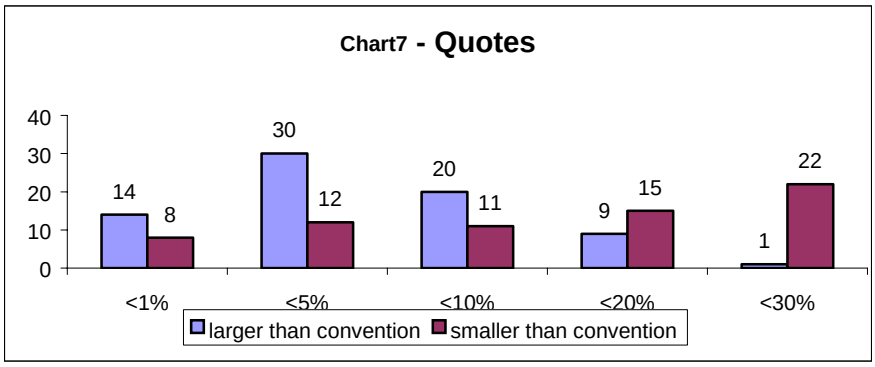


Chart7 - Quotes
40
30
20
10
0
14
8
30
12
20
11
9
15
1
22
<1%
<5%
<10%
<20%
<30%
larger than convention
smaller than convention

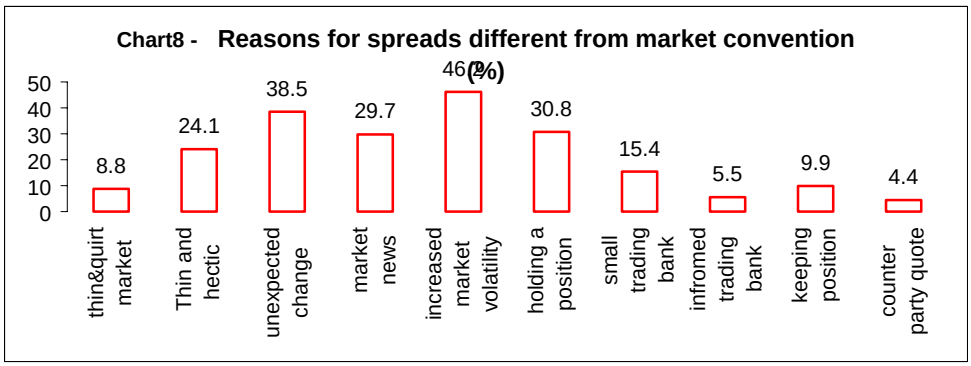


Chart8 - Reasons for spreads different from market convention (%)
50
40
30
20
10
0
8.8
24.1
38.5
29.7
46.2
30.8
15.4
5.5
9.9
4.4
thin&quirt market
Thin and hectic
unexpected change
market news
increased market volatility
holding a position
small trading bank
infromed trading bank
keeping position
counter party quote

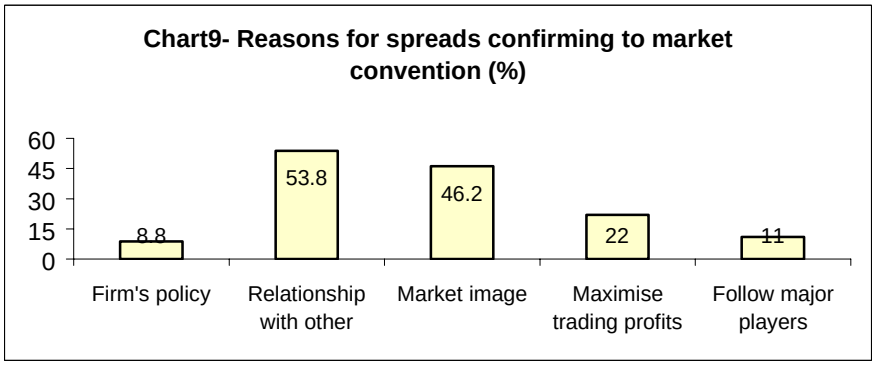


Chart9- Reasons for spreads confirming to market convention (%)
60
45
30
15
0
8.8
53.8
46.2
22
11
Firm's policy
Relationship with other
Market image
Maximise trading profits
Follow major players

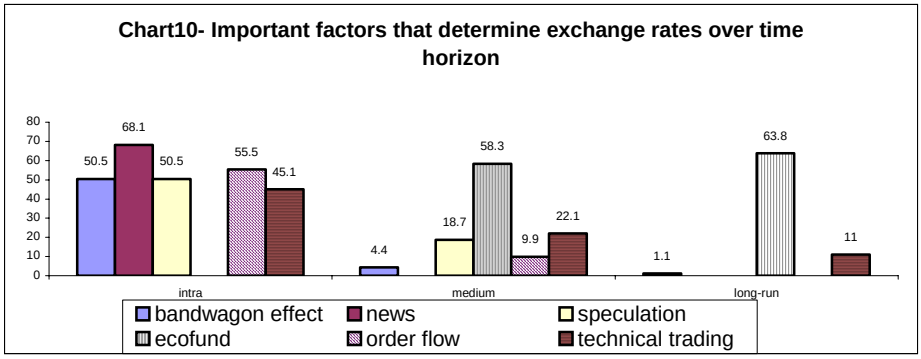


Chart10- Important factors that determine exchange rates over time horizon
80
70
60
50
40
30
20
10
0
50.5
68.1
50.5
55.5
45.1
4.4
18.7
58.3
9.9
22.1
1.1
63.8
11
intra
medium
long-run
bandwagon effect
news
speculation
ecofund
order flow
technical trading

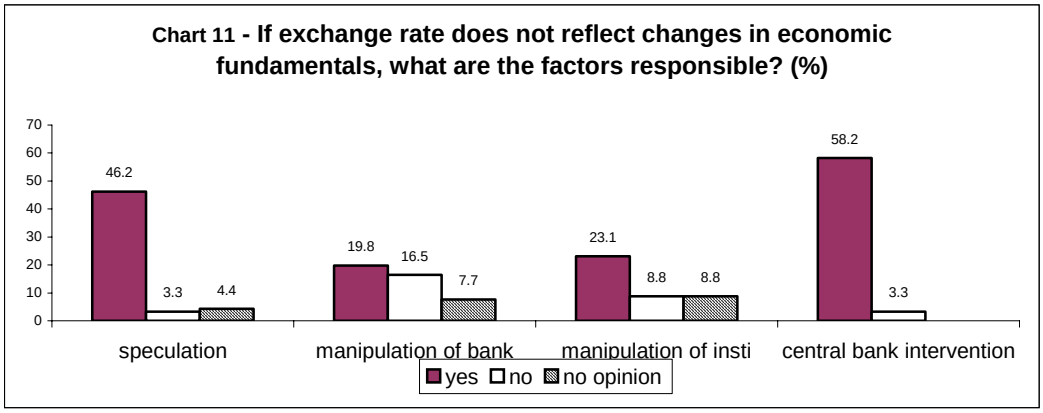


Chart 11 - If exchange rate does not reflect changes in economic fundamentals, what are the factors responsible? (%)
70
60
50
40
30
20
10
0
46.2
3.3
4.4
19.8
16.5
7.7
23.1
8.8
8.8
58.2
3.3
speculation
manipulation of bank
manipulation of insti
central bank intervention
yes
no
no opinion

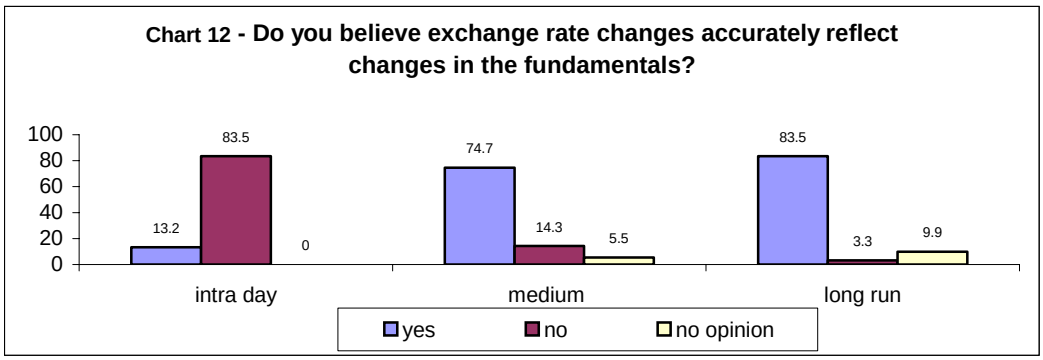


Chart 12 - Do you believe exchange rate changes accurately reflect changes in the fundamentals?
100
80
60
40
20
0
13.2
83.5
0
74.7
14.3
5.5
83.5
3.3
9.9
intra day
medium
long run
yes
no
no opinion

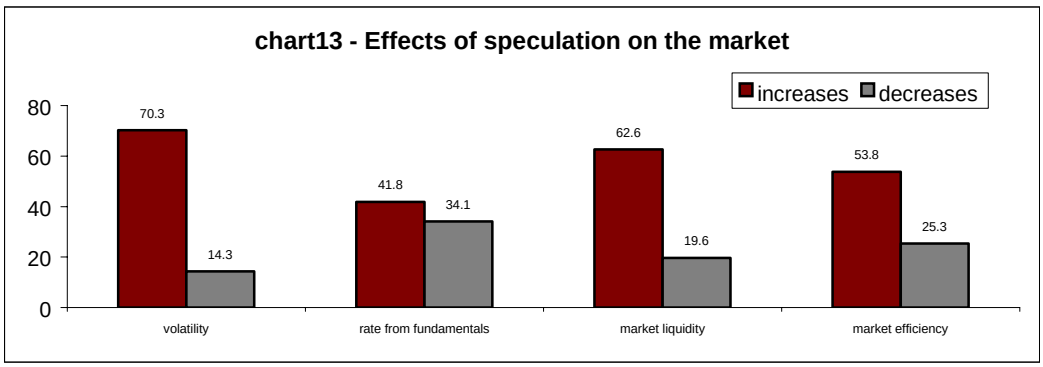


chart13 - Effects of speculation on the market
increases
decreases
80
60
40
20
0
70.3
14.3
41.8
34.1
62.6
19.6
53.8
25.3
volatility
rate from fundamentals
market liquidity
market efficiency

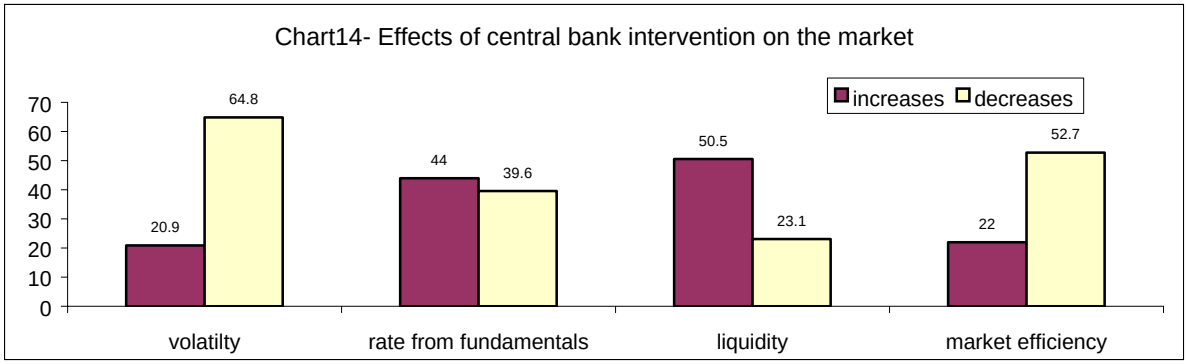


Chart14- Effects of central bank intervention on the market
increases
decreases
70
60
50
40
30
20
10
0
20.9
64.8
44
39.6
50.5
23.1
22
52.7
volatilty
rate from fundamentals
liquidity
market efficiency

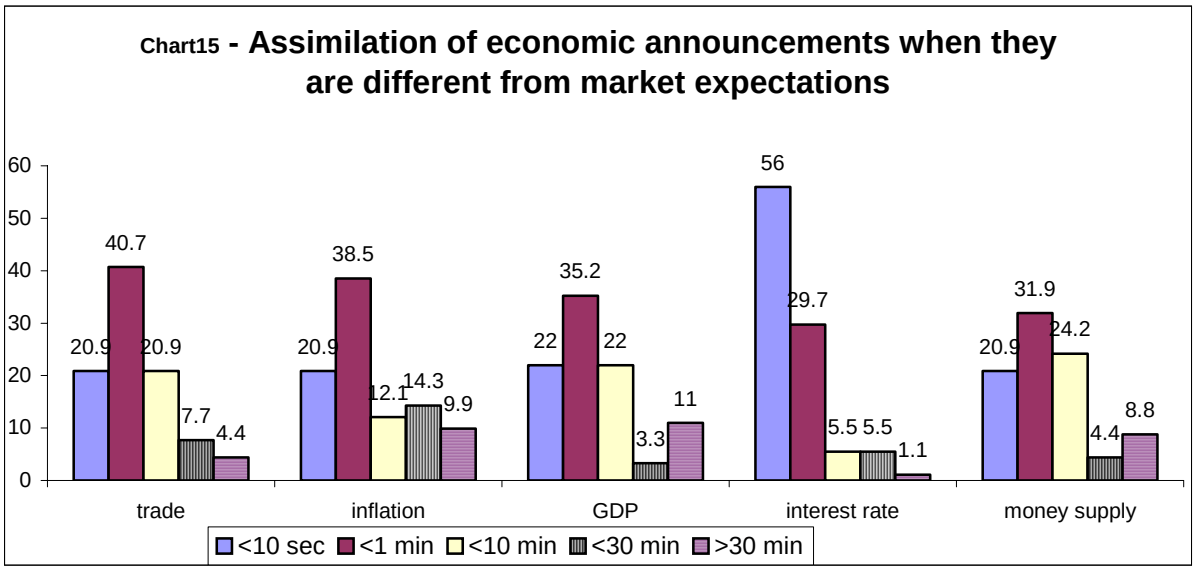


Chart15 - Assimilation of economic announcements when they are different from market expectations
60
50
40
30
20
10
0
20.9
40.7
20.9
7.7
4.4
20.9
38.5
12.1
14.3
9.9
22
35.2
22
3.3
11
56
29.7
5.5
5.5
1.1
20.9
31.9
24.2
4.4
8.8
trade
inflation
GDP
interest rate
money supply
<10 sec
<1 min
<10 min
<30 min
>30 min

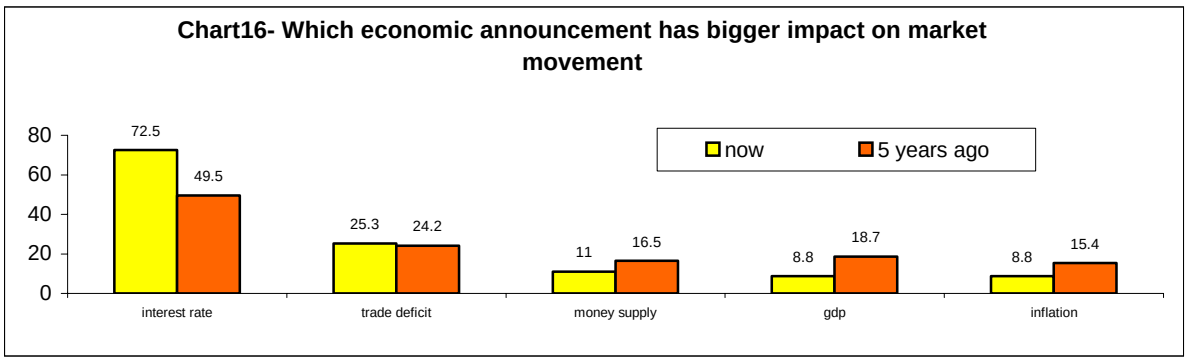


Chart16- Which economic announcement has bigger impact on market movement
80
60
40
20
0
72.5
49.5
25.3
24.2
11
16.5
8.8
18.7
8.8
15.4
now
5 years ago
interest rate
trade deficit
money supply
gdp
inflation

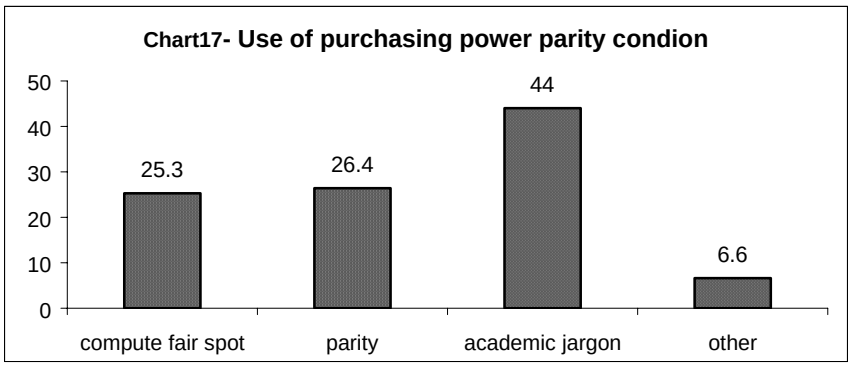


Chart17- Use of purchasing power parity condion
50
40
30
20
10
0
25.3
26.4
44
6.6
compute fair spot
parity
academic jargon
other

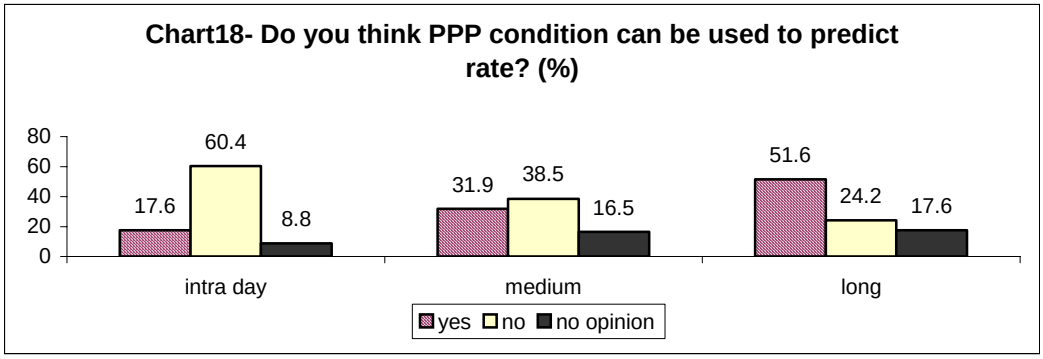


Chart18- Do you think PPP condition can be used to predict rate? (%)
80
60
40
20
0
17.6
60.4
8.8
31.9
38.5
16.5
51.6
24.2
17.6
intra day
medium
long
yes
no
no opinion

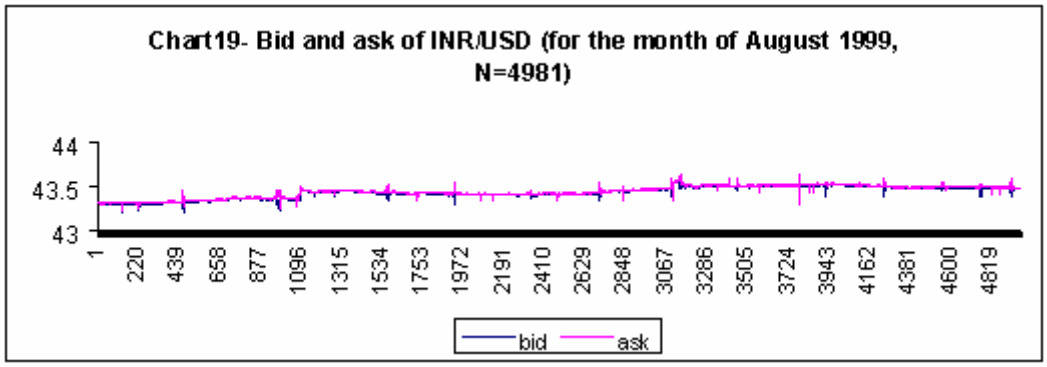


Chart19- Bid and ask of INR/USD (for the month of August 1999, N=4981)
44
43.5
43
1
220
439
658
877
1096
1315
1534
1753
1972
2191
2410
2629
2848
3067
3286
3505
3724
3943
4162
4381
4600
4819
bid
ask

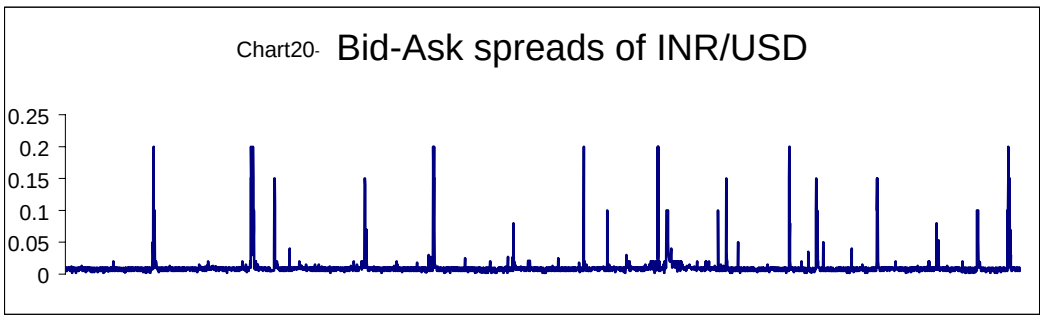


Chart20- Bid-Ask spreads of INR/USD
0.25
0.2
0.15
0.1
0.05
0